

REMARKS/ARGUMENTS

In the Office action dated July 23, 2004, the Examiner objected to the Specification because of misnumbered drawings on Page 2 thereof. The drawing numbers are corrected by this Amendment.

The Examiner rejected claims 1-14, all of the claims in the Application under 35 U.S.C. § 103(a) as being unpatentable over U. S. Patent No. 6,723,643 B1 to Pan *et al.* in view of U. S. Patent No. 5,504,041 to Summerfelt.

In the Specification, page 2 is amended to correct a drawing number.

In the Claims, claim 1 is amended.

The Invention

Experimental data demonstrates that, during programming, the resistivity of RRAM material near the cathode is switched to a high resistivity state while that near the anode is switched to low resistivity state. The conversion of the resistivity occurs during the instance when a narrow voltage pulse is applied to the device, which causes a voltage drop near the cathode. There is a clear onset voltage required for the resistivity changes. It is also experimentally found that the material needs a certain oxygen content, as when the oxygen content is too low, there is no resistivity change.

If the electrode of a RRAM memory cell is not oxidation resistive, the electrode will be oxidized during the fabrication process temperature treatment, or will be gradually oxidized by the current-voltage-generated heat during normal operation. At the same time that electrode oxidation occurs, oxygen diffuses from the RRAM material to the electrode, causing an oxygen deficit region. Both the oxidized electrode and the oxygen deficit region have high

resistance. In addition, the oxygen deficit region cannot be changed to the low resistance state by electrical pulse.

A RRAM electrode must not react with the resistor material. A noble metal electrode is preferred. However, most of the noble metals do not block oxygen diffusion. Therefore, a multi-layer electrode is required. The structure and method of the invention describe the fabrication of such a device, which includes a substrate having a N+ or P+ junction formed therein, a metal plug extending upwards from the junction through an oxide layer to a multi-layer electrode RRAM memory cell. The RRAM memory cell includes layers of oxidation resistant material, refractory metal layers, and a layer of metal, specifically, in the preferred embodiment, a layer of colossal magnetoresistive (CMR) material. These layers are formed sequentially directly on the preceding layer, without any intervening structure or layer. As shown in the drawings, the layers are stacked on one another, and have the same relative size throughout the stack.

The Applied Art

U. S. Patent No. 6,723,643 B1 to Pan *et al.*, describes a technique for CMP of thin films using indicator structures to provide notice of the removal of a predetermined amount of the overlying layer. As the Examiner correctly points out, Pan *et al.* do not teach nor suggest providing a CMR layer between first and second refractory metal layers and first and second oxidation resistive layers.

U. S. Patent No. 5,504,041 to Summerfelt describes a multi-layer structure including layers of oxidation resistant material, layers of refractory metals, a layer of a high-k dielectric and a layer of CMR material, however, Summerfelt does not arrange the layers as

required by the claims in the Application. Further, as shown in applied Fig. 16, the layers are not "stacked" in that they are shown with vastly different sizes and orientations.

The Claims

Amended Claim 1 now recites that the recited layers are formed directly on the underlying layer, and that they form a stack, *i.e.*, they have the same horizontally disposed size. Such structure is neither taught nor suggested by the applied art, taken alone or in combination. The limitation of forming the layers on the preceding layer is described in the Specification as filed, and also in claim 8, thus, the limitation added to claim 1 do not constitute new matter and does not constitute an amendment which allows the Examiner to apply art not already applied or cited in this Application. Neither reference teaches nor suggests that the layers are formed in a stack, *i.e.*, having the same horizontal size. Claim 1 is allowable over the applied and cited art.

Claims 2, 4, and 6 are allowable with their allowable parent claim.

The Examiner has applied a rule to the drawings on the applied references and concluded that the thicknesses of the various layers are drawn to scale. There is no mention that the drawings are drawn to any particular scale, thus the Examiners rejection of claim 3, 5 and 7 is without support in the applied references. Claims 3, 5 and 7 are allowable over the applied art. As described in the Specification, the thicknesses of the various layers are critical, as the layers are provided to prevent the oxidation of protected layers. This is another reason that claims 3, 5 and 7 are allowable over the applied art.

The Examiner provided only a blanket rejection of claims 8-14, applying the same two references and reasoning as in the rejection of claims 1-7, however, claim 8, as noted above, requires that the recited layer formation steps result in the formation of a layer on the previously

formed layer, e.g., *depositing a first oxidation resistant layer on the metal plug*, can only be interpreted to mean that the first oxidation layer is formed on the metal plug: formation of any structure between the metal plug and the oxidation layer does not fall within the plain meaning of the claim language, and does not anticipate nor render the claim obvious. Claims 8-14 are allowable over the prior art of record.,

In light of the foregoing amendment and remarks, the Examiner is respectfully requested to reconsider the rejections and objections stated in the Office action, and pass the application to allowance. If the Examiner has any questions regarding the amendment or remarks, the Examiner is invited to contact the undersigned.

Provisional Request for Extension of time in Which to Respond

Should this response be deemed to be untimely, Applicants hereby request an extension of time under 37 C.F.R. § 1.136. The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any over-payment to Account No. 19-1457.

Respectfully submitted,

Date:

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